



The Effect of Big Data Analytics on Predictive Policing Through Crisis Management: A Proposed Framework

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ABSTRACT

Crisis's have long been a scourge for humanity. With the advances in technology (in terms of computing, communications, and the ability to process, and analyze big data), our ability to respond to crisis is at an inflection point. There is great optimism that big data tools can be leveraged to process large amounts of crisis-related data to provide an insight into the fast-changing situation and help drive an effective disaster response and predictive policing. Predictive analytics and artificial intelligence are applied widely across law enforcement agencies and the criminal justice system. Understanding how the "big data analytics" discourse is operationalized as a series of technical fixes that rely on the production of indeterminacies allows for a more nuanced critique of predictive policing. This paper introduces the effect of big data analytics on predictive policing through crisis management.

1. Introduction

The age of big data is evident in every aspect of our modern life. Today, large and government organizations rely on big data to support their work and mission. But there are also significant drawbacks linked to the usage of big data analytics. The fact that big data are typically biased, overly complex (Kaffash et al., 2021). Despite big data include certain crucial information; there are lots of biased information that produced misleading in some circumstances which affect the fairness and impartiality in the decision-making process (McFarland and McFarland, 2015). In addition, the traditional data analytics may not be able to handle such large quantities of data and distinguish between biased and non-biased information. In fact, the problems of analyzing the large-scale data did not suddenly occur but have been there for several years because the creation of data is usually much easier than finding useful things from the data (Tsai et al., 2015). The most basic rationale is that traditional prediction techniques are incapable of dealing with the magnitude, speed, and complexity inherent with big data (Kaffash et al., 2021). Concerns have also been expressed about the quality and integrity of data used for policing application, which may not be usable in doing algorithmic analysis (Alexander and Marion, 2020).

Despite the vast development of technology in policing, the adoption of information technology in law enforcement is not always successful and free from errors or biased results. One of the problems noted by Giest (2017) and Ingrams (2019) is the government agencies lack of institutional support for big data management and shortage of sufficient capabilities to conduct accurate analysis on huge volume of data. Some scholars suggest that the potential of big data is evident in raising policing effectiveness in term of precision of crime prediction. However, there are some concerns regarding the complexity of big data and the lack of expertise to select the useful data from useless data (Alexander and Marion, 2020). This can be accomplished through training government employees to understand the concept of big data and how to identify the useful information from a large volume of unstructured data (OECD, 2018). In this context, Günther et al. (2017) addressed some of the problems involved with implementing big data, one of them is that public organizations and associated agencies must establish sufficient capacity for an appropriate application of big data analytics. According to MAMPU (2016), when the government lacks analytical capacity, it must seek out new stakeholders with the necessary skill sets. Moreover, big data extends to wide range of fields, it would be a difficult task to benefit from this technology without the right application for big data analytics because the process of crime prediction is complicated and linked to several factors, some of them associated with human errors shortage of necessary resources. In other words, the adoption of big data for the sake of predictive policing can only by trustworthy if the police provide the necessary resources to make this plan successful. As this technology is relatively new, whereas more research yet to report more details. Thereby, it is important to identify how big data analytics contribute to predictive policing, and what other factors (e.g., crisis management) may contribute to predictive policing. The UAE is one of the leading countries in the world that produce and receive a large amount of data every day. However, to identify useful information from the big data remains a challenge (Alkatheeri et al., 2019). It is not clear to the present how big data analytics promote predictive policing in UAE because this technology is still developing and new. As predictive policing utilizes two techniques; the first is geographic which uses geospatial data to identify hotspots where crime is likely to occur in the future, allowing police departments to beef up surveillance in certain regions. The second is social which examines social networks and human behaviors to detect potential offenders or, conversely, individuals who are more likely to become

victims (Jens, 2021). Unfortunately, there is an absence of empirical reports to know how well Dubai police using these two techniques in predicting criminal activities.

In other sense, the vast development in the adoption of technology in law enforcement, and the predictive policing reliance on algorithms for crime anticipation, has increased the pressure on police to deal with the large amount of sophisticated data (Mugari and Emeka, 2021). This scenario might affect the performance of police, e.g. despite the predictive policing helps to control criminal activities, it can also preserve criminal activities. Whereas criminals could use data analytics to strengthen their operations by reverse engineering predictive policing or counter predictive police (Gstrein et al. 2020). Thereby, predictive policing should be implemented by professionals and experts in this field in order fight crimes. Yet, there is a lack of empirical results on the role of computational methods based on big data in the context of predictive policing (Jens, 2021). While the relationship between big data and predictive policing must be evaluated, taking into account all significant and small issues connected to recently acquired technical breakthroughs in order to understand the basic foundation of applying big data analytics in policing (Gourisha and Abdul, 2020). The previous arguments reveal that the literature have already reported the potential of big data technologies to increase police capabilities to predict crimes, but concerns have been expressed about the lake of expertise in using big data appropriately to promote predictive policing. In brief, the key challenges to successful implementation of predictive policing in the UAE police departments is the absence of empirical data on the role of big data to foster predictive policing and crises management. The insufficient skills in handling big data and lack of resources in this technology has been attributed to weak performance in law enforcement (Alexander and Marion, 2020). Hence, an in-depth discussions and further investigations to provide clear understanding on these challenges will provide a bigger picture to the people in charge of big data analytics in Dubai police departments.

2. Literature and Hypothesis Development

The previous debates and arguments reveal many models and theory introduced in the literature to manage crises, but the questions arise, what is the most appropriate crisis management theory for law enforcement organization such as police departments. Coombs (2012) claimed that the two most influential models and theories in the discipline of crisis management in the public sector are Fink's (1986) four-stage model of a crisis lifecycle and Mitroff's (1994) five-stage model. As this study focus on the mediating influence of crises management, the five steps of stages of Mitroff's model explain how big data contribute to this process in the signal detection, whereas the large volume of data available from lots of resources could be highly useful for the team who do manage and analyze possible crises, e.g., the role of artificial intelligence in social media big data analytics has been proven to promote disaster management-initial results (Nunavath and Goodwin, 2018). Big data technology enables the early detection of crises through utilizing the predictive analytics capability in crisis management (AL-Ma'aitah, 2020). Because big data analytics is the best tool for disaster response and recovery, for example big data from social media can be used in crisis response for various purposes like, communicating with public during disaster response and recovery, detect early warning messages (Ragini et al., 2018). Hence, a framework based on big data analytics and crisis management could precisely explain how and predictive policing can be improved (Brian, 2005). Hence, the Mitroff (1994) is more appropriate for the mission of law enforcement and in particular predictive policing so that security crisis can be predicted based on big data analytics in the early stage of crisis management (i.e. signal detection) of Mitroff's crisis management theory. Mitroff (1994) developed a model that divides crisis management into five stages as shown in the Figure 1:

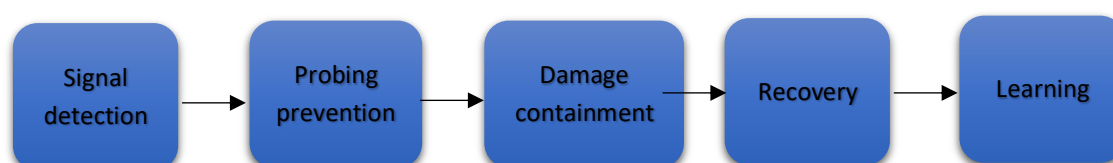


Figure: 1 Five-stages model of crisis management (Mitroff, 1994).

As illustrated in the diagram above, Mitroff's crisis management paradigm is divided into five stages: (1) signal detection; (2) probing and prevention; (3) damage containment; (4) recovery, (5) learning. Mitroff's crisis has an edge significance over another crisis management model. The first two stages (e.g., signal detection, probing and prevention), cover the proactive efforts that an organization can take prior to a crisis event.

2.1 Predictive Police in UAE

The predictive policing is a tool, not an aim in itself. As a result, law enforcement organizations should use other tools in parallel to big data analytics like crisis management. To that end, this study suggests that predictive policing has a bright future in UAE, but that it must continue to overcome the challenges that impede its success. Predictive policing employs data-driven analytical tools backed by algorithms to assist cops in determining where and when a crime is most likely to occur. Database sets of rules will make decisions in predictive policing using everyday computing (Zwitter, 2015). Dubai has demonstrated its desire to become the world's smartest police force, which will be aided by the most advanced

Artificial Intelligence (AI) technologies and apps. In recent years, the Dubai Police stated that their AI-powered smart system as the first country in the Arab world to implement predictive policing based on AI (Alosani et al., 2020). In 2016, the chief of Dubai Police declared that its latest predictive policing program, has been successfully installed in the headquarter office. This program, the first of its type in the area, was created in support of the UAE's Smart Governance Initiative and was specifically built to supplement the Dubai Police Department's modernized approach to crime prevention and better public safety. Crime Prediction examines existing intelligence and crime patterns from police databases and generates highly accurate statistics about when and where crime is likely to occur next using advanced algorithms. This intelligence is then used to notify patrol teams about which districts may require greater resources to combat possible criminal activities (SIME, 2016).

Space Imaging Middle East (SIME) is a market-leading complete solutions provider that incorporates all aspects of the satellite imagery value chain. SIME collaborated with Dubai Police on the application of predictive software on this major project. This software is unique in its capacity to reliably recognize intricate patterns of criminal behavior in seemingly unconnected occurrences and then estimate the likelihood of recurrence. The result is improving the performance of Dubai police in the arrest of over 100 wanted criminals since the beginning of applying predictive policing in 2018. His Excellency Major General Khalil Ibrahim Al Mansouri, Assistant Commander-in-Chief of Criminal Investigation, affirmed that the AI project in police comprises advanced smart devices to help reduce crime rates and improve people's safety and security (SIME, 2016).

In summary, data has long been used by police departments in modern countries like UAE, whether it's to track crimes on a map, track terrorist groups, or maintain track of repeat offenders. Authorities are now eager to apply cutting-edge analytical techniques to minimize crime and solve prior crimes in the country. This analytical practice is primarily concerned with identifying potential criminals for police intervention. Law enforcement in Dubai utilized predictive technologies and data analysis to foresee offenders and the rates of crimes have witness a significant decrease in recent years. In 2021 the level of crimes marked a significant decrease of 19% from the 54 cases reported in 2020 (Salam, 2021). Furthermore, Dubai records 99.5% drop in unresolved, as well as disturbing crimes, thanks to the latest predictive technologies used by Dubai police department (Amira, 2019).

2.2 Big Data Analytics

Big data analytics is powering everything people do online today in every industry. Data is also available in a variety of formats, including structured data, semi-structured data, and unstructured data. In a standard Excel sheet, for example, data is classed as structured data with a certain format. Emails, on the other hand, are classified as semi-structured data, while photos and videos are classified as unstructured data. Big data group all these types to form a large volume of data. Sun (2015) suggested that big data analytics is a process of collecting, aggregating, examining, and exploiting massive volumes of data from disparate and autonomous resources to identify patterns and other useful information for better managerial decisions.

In other words, big data analytics is a developing field of study related to huge amount of data, and with technological advancements and the ever-increasing volume of data produced every day, various tools and methods are still being developed by various innovation agents, such as Microsoft, IBM, Tableau, and Palantir, all these companies utilize big data analytics to gain unlimited advantages (SharesPost, Inc., 2017). Big data analytics enable the implementation of new approaches for data collection and analysis, allowing for new ways to ask and answer certain questions that help stakeholders in various industries, such as health, manufacturing, education, and law enforcement. Rather of attempting to extract insights from datasets that are limited in scope, temporality, and quantity, big data analytics solves the problem of handling and investigating massive, dynamic, and diverse datasets.

The solutions of big data analytics are based on machine learning and complex algorithms (Kitchin, 2014). Kude et al. (2017) claimed that big data analytics refers to the collection of a vast amount of data and technology from various sources that allows an organization to achieve a competitive advantage through improved organizational performance. It is important to note that the analytical abilities and tools are critical mechanisms for big data analytics (De Mauro et al., 2016). Big data analytics includes a variety of techniques for inspecting data that businesses obtain from various sources to uncover significant trends. According to McAfee and Brynjolfsson (2012), big data analytics is a potential value creator that many businesses are implementing to help them make decisions. Analytical methods for evaluating huge data were necessary for effective execution of big data analytics (Cao et al., 2015). Hence, to discover implications and build intuitions, big data analysts must have certain skills (Stubbs, 2014).

2.3 Crisis Management

A crisis as an abnormal circumstance that poses major risks to an organization or the country and has the potential to become a disaster if ignored or mismanaged (Abdul and Tayyibah, 2010), a crisis is an unprecedented situation that does not allow for much planning. A crisis as an occurrence contains elements such as surprise, threat, and a limited response time (Tarawneh, 2011). A crisis is an unanticipated event. As a threat, the crisis must be addressed immediately so that the organization can resume normal operations (Fajri and Mawadati, 2018). When organizations attempt to cope with a crisis, this is referred to as crisis management. When there is a shortage and the organization is in crisis, it must deal with

it as soon as viable. Tarawneh (2011) claimed that if the crisis worsens, it could lead to catastrophe situation which could not be controlled or avoided. In other words, a crisis is characterized as occurrences that exceed the strength of society, businesses, and systems, necessitating tremendous efforts to recover and restore to return to normal situation (Sa'diyah, 2013). Others stated that a crisis is an incident or a series of circumstances that jeopardizes an individual's or organization's safety, reputation, or even survival (Junhong and Vanhala, 2010).

The number of potential crises is huge, but crises can be concentrated in a specific period of time (Coombs, 1999). It is critical to recognize different types of crises during the crisis management process because different crises need the deployment of different crisis management solutions and methods. In this regard, Lerbinger (1997) classified crises into eight types: natural disasters, technological crises, confrontation, malevolence, organizational misdeeds, workplace violence, rumors, terrorist attacks/man-made disasters that occur when the crisis is caused by people, such as global financial crises, transportation accidents, and massive destruction. The term 'crisis management' refers to the comprehensive handling of a crisis. Smith (2005) defined crisis management as a treatment by a specialist team according to circumstances outside the organization's control (Smith, 2005). Crisis management is divided into three stages: (1) pre-crisis, (2) crisis, and (3) post-crisis (Sa'diyah, 2013). Pre-crisis can be viewed as the earliest endeavor to collect data linked to the crisis issue and detect difficulties an organization might face when a crisis happens. The crisis management takes the shape of implementing a program strategy to deal with the crisis based on large scale of data. This method is related to identifying problems as the foundation for developing a crisis plan. Post-crisis management is the following stage of crisis management. This step tries to assess the process of putting a crisis plan into action. In brief, the previous arguments indicate crisis management encompasses a variety of issues, including strategies for responding to both the reality and perception of a crisis, as well as defining metrics to determine what scenarios constitute a crisis and, as a result, should trigger the necessary reaction mechanisms.

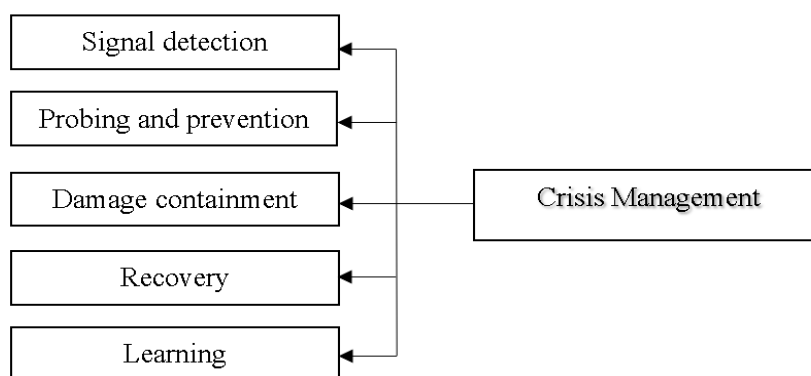


Figure: 2 The dimensional model of crisis management.

2.4 Predictive policing

Predictive policing is the utilization of data, combined with using machine learning or mathematical algorithms to predict the threats of crime in precise locations and predicting the times for committing possible criminal activities. Predictive policing has raised confidences and expectation as well as strengthened the application of big data technology for crime control (Chan and Bennett, 2016). Predictive policing also defined as the use of analytical techniques to identify promising targets for police intervention with the goal of preventing crime, solving past crimes, and identifying potential offenders and victims (Carrie and James, 2017). It has been reported that police officers had achieved a remarkable success in using predictive analysis to reduce crimes rates in some developed countries like the US and UK (Hayes, 2015). Big data is increasingly being employed in several sectors of human activities, with potentially important implications for our society in various way such as prediction of future crimes. The role of big data in predictive policing can't be denied (Mayer-Schönberger and Cukier, 2013). Nowadays, many police agencies utilize predictive analysis as part of a technique known as "predictive policing" to identify potential future criminal locations and then implement interventions to prevent or stop criminals in those locations. The analysis's accuracy appears to be depending on the quantity and quality of previous data available for examination (Hayes, 2015).

The term predictive policing refers to a variety of analytic techniques and law enforcement practices. It is also claimed as "ability of police to predict where and when the next crime or series of crimes will take place" (Uchida 2013, p3871). Along with improvements in law enforcement decision making, notably officer deployment, based on big data forecasts, binds these together to reach to a specific conclusion. The analytic element, as practiced primarily consists of special software tool that analyses historical crime data (and sometimes other data such as social media, weather, and mortgage defaults) to predict where, but sometimes by whom or to whom, crime will occur in the future. The major claim of big data is that it will transform the work of police in big cities and that, because modern police rely on data-driven, evidence-led, and algorithmically analyzed data, it is the new era of policing (Carrie and James, 2017). Big data analytical software

providers, law enforcement officials all data they need in order to actively support the use of these types of data for crime prevention. However, some authors argue that people should be cautious in their expectations of what predictive analytics can do. While there appears to be a link between the installation of predictive analysis tools and a reduction in crime, there is no proof of a direct cause and effect relationship. Other elements, such as demographics, economics, and a variety of other societal issues, should be addressed when determining the cause of lower crime in any given area (Singh, and Reddy, 2015).

Predictive policing is a policing methodology that use sophisticated computer tools to forecast future crimes based on historical crime and socio-demographic data from different sources. The fundamental purpose of crime prediction is to assist law enforcement in combating crime, both strategically and tactically. Thus, crime prediction in and of itself is insufficient until the results of crime prediction are used for decision making, particularly those involving the deployment of persons and resources (Meijer and Wessels, 2021). Predictive policing is defined by Perry et al. (2013) as the use of analytical tools, particularly quantitative techniques, to identify likely targets for police involvement and to prevent or solve past crimes by making statistical forecasts (Perry et al. 2013). Similarly, Meijer and Wessels (2019) stated that “predictive policing is a concept that is predicated on the notion that it is possible to forecast when and where crimes will occur again in the future by employing advanced computer analysis of information about previously committed crimes” (p.1033). Moreover, Meijer and Wessels (2019) claimed that predictive policing is the collection and analysis of data about previous crimes for the identification and statistical prediction of individuals or geospatial areas with an increased probability of criminal activity to aid in the development of policing intervention and prevention strategies and tactics. While the concept appears to encompass the core principles of predictive policing, it may be a little convoluted.

Table: 1 Relevant study to the research context

Author/Year	Objectives	Findings
Singh, and Reddy, 2015	To go over an in-depth examination of hardware and software platforms for big data analytics.	The research solely looked at the hardware and software platforms utilized for big data analytics. The focus of the review is on the impact of criteria such as scalability, data volumes, and resource availability on big data analytics. However, the review did not cover the most recent big data analytics apps and technologies for successful business decision making.
Hashem et al., 2015	To examine the relationship between big data and cloud computing	Discuss the fundamentals of cloud computing and big data technology. Furthermore, the study presents fundamental definitions, characteristics, and problems for implementing big data analytics in a cloud computing environment.
Tsai et al., 2015	To provide a high-level overview of big data analytics in terms of data mining and knowledge discovery approaches.	Discuss the classic data mining, knowledge discovery, and distributed computing approaches for big data analytics. Nonetheless, little mention was made of the problems, applications, current technologies, or data sources for big data analytics.
Mohebi et al., 2016	To examine iterative clustering algorithms for huge data processing utilizing the MapReduce architecture.	The focus of the review is on the iterative clustering strategy for big data processing.
Mohamed et al., 2019	To give a literature review that assesses various tools and methodologies, applications, and trends in big data research.	This study is directly related to our review because it presents big data analytics techniques, trends, and applications. Nonetheless, the study fails to present the many analytics kinds that serve as the foundation of big data analytics. Furthermore, the study did not go into detail on the measures that are essential for success in big data and business analytics. Furthermore, the constraints and future research directions for big data analytics were not discussed effectively.
Ifeyinwa et al., 2019	To examine big data analytics methodologies and how they can contribute to company success.	The report provides an in-depth examination of big data and business analytics technologies, applications, data sources, and problems. In addition, the paper discusses the advantages and disadvantages of various big data techniques, as well as open research topics that need to be explored further.

Ho et al., 2021	To investigate Big Data applications: exploratory data analytics of public safety	Public engagement and data analytics can be used jointly in the big data era, this case study shows that even with its great promise, Big Data applications cannot replace careful evaluative design and thoughtful consideration of ethical issues and public value questions in policymaking and program management
Oatley, 2021	This paper examines the impact of new AI-related technologies in data mining and big data on important research questions in crime analytics.	While big data analytics offers great potential for a better society, there are many factors that need serious consideration such as bias using big data and analytics in profiling and predicting criminality; forecasting crime risk and crime rates; and, regulating AI systems.
Henriques et al., 2020	The aim of this study to identify major debates on big data analytics, presenting its evolution over the past years and identifying its research tendencies.	The findings suggest that big data analytics is apparently reaching a high level of development various fields, which might be confirmed by publications in the following years. They concluded that other perspectives on big data analytics might include a new wave of studies and that new paths beyond productivity gains can be

Source(s): The study's authors

The previous arguments reveal that big data analytics gave deep data-driven insights into the competitive advantages earned by large organizations (Wang et al., 2018). Notably, some researchers regard big data analytics as the "fourth paradigm of science" (Agrawal and Choudhary, 2016). Similarly, Hagstrom (2012) asserted that big data analytics is a "new paradigm of knowledge assets", other claimed that it is the next edge of innovation, competitiveness, and productivity (Wedel and Kannan, 2016). Other scholars considered big data analytics as a critical differentiator and a key to growth by high-performing organizations (Thirathon, 2015).

In addition to that, big data analytics may boost organizational outputs and foster industries in a variety of ways. These include enhanced health-care delivery, educational standards, national security, and the ability to engage in good government (Grover et al., 2018). Furthermore, big data analytics has the potential to help policymakers gain insight into enabling policies that will provide a safe playground for investors (Chahal et al., 2019). Furthermore, an education monitoring agency can use big data and business analytics methodologies to analyze teacher effectiveness and improve work attitude. Additionally, mobile network position data can be utilized for traffic management in order to avoid traffic bottlenecks in major cities or to better organize the public transportation system (Ifeyinwa et al., 2019).

2.5 Theoretical Gap

The review of literature on the topic of policing reveal that big data analytics is linked to crisis management, while big data analytics is third variable interact between them. In theory, the review of previous academic works shows that Mitroff's crisis management theory has not been used to explain how law enforcement agencies deal with crises through predefined stages (i.e. signal detection; probing and prevention; damage containment; recovery, learning). There have been lots of study that used Mitroff's theoretical model in industries, business, and manufacturing (Mitroff, 1994). However, none of them in the field of law enforcement and policing. As explained in this paper, the capability of police is driven by limited volume of data in the past, while at the present time the performance of modern police is largely depending on big data to fight the most complicated crimes and offenders who by themselves rely on the science of big data to commit new types of crimes (e.g. cybercrimes, hacking, social network traps, financial frauds, identity illegal information, theft and sale of corporate data).

These crimes require advanced predictive methods in parallel with effective crises management strategy to deal with all kinds of crises (financial, technological, natural, community, pandemics, human-made disasters, acts of malevolence). However, the researching on the connections between these variables was not widely covered, with relatively little focus on the underlying criminological theory from the perspective of big data. The study of crisis management framework on which the big data technology is based is essential to have a bigger picture on the how crises management utilize big data escape the worst consequences of aforementioned crises (Alexander and Marion, 2020). As the findings in the literature reveal that big data analytics afford the possibility of reframing the performance of almost every organization at the current technological era (Kitchin, 2014), this topic was not studied in UAE policing, while the focus by most scholars in the past was mainly on the role of innovation tools in fostering the performance of police (Alshamsi and Isaac, 2019; Alosani et al., 2020; Almazrooei et al., 2021). The literature review indicates of dearth of studies that highlight the role of big data analytics on predictive policing in UAE, as well as examining the mediating role of five stages of Mitroff's crisis management theory on this relationship.

In summary, big data analytics showed great results to foster the performance of police in almost all developed countries. Today, the power of big data cannot be denied in controlling the level of crimes, especially those rely on technologies

and sophisticated malicious software. However, the research in this discipline is still evolving and not yet established well in developing countries such as UAE. Nevertheless, a comprehensible understanding of big data analytics, and its definition and influence on police work in developing countries is still not widely covered (Uthayasankar et al., 2017), while examining the relationship between the application of big data analytics and crisis management remained scarce (Mikalef, 2018; Qasim et al, 2020). In addition to that, big data analytics is still considered an innovation tool in the early stages of development and research which require more academic investigation and further empirical evidences (Kitchin, 2014), especially in the domain of law enforcement and policing.

2.6 Hypothesis Development

2.6.1 The Relationship Between Big Data Analytics and Predictive Policing

The review of literature shows that big data analytics is linked to each other and when police departments utilize big data analytics in law enforcement, they improve their ability in crime prediction, as well as prepare for security crisis at the right time. The empirical evidence found from the literature confirm the association between big data analytics and predictive policing, whereas algorithmic analysis of big data about crimes trends is used in a predictive policing systems (Sandhu and Fussey, 2021). The emergence of 'intelligence-led policing' can be linked to the concept of replacing subjective police discretion with the effectiveness of big data analytics (Hung and Yen, 2021). Several authors in this field suggested that big data analytics has a direct effect towards predictive policing as will be explained in this section. Carrie and James (2017, p.7) stated that "predictive policing relies on computer algorithms to see patterns, predict the occurrence of future events based on large quantities of data, and aims to carefully target police presence to the necessary minimum to achieve desired results". The significance about predictive policing is the increased power of the big data analytics which in order to achieve mobilization of categorical criminal suspicion activities (Ericson., 2007).

The mission of law enforcement has been changed dramatically by technology advancement over the past two centuries. Today, big data has revolutionized many industries, including the police and law enforcement (Aruni, 2018). The collection and use of data have always been an aspect of police work, technological advancement and increased availability of policing data have led to a shift from predominantly reactionary police work towards a more proactive policing (Jansen 2018; Sandhu and Fussey, 2021). It is evident that data are used for predictive in many businesses and industries, in addition to other purposes like explanatory goals (Brayne, 2017). Chan and Bennett (2016) claimed that the interest of predictive policing software in the United States with the usage of big data has created a new horizon in policing, whereas big data technology can make policing smarter and information-based rather than subject to human interfere which could bias the results in many cases. Thereby, big data analytics can be useful in all law enforcement aspects, such as crisis and emergency prediction either before the initiating unexpected event (e.g., earthquake, tsunami) or as part of the public riots and political crisis (Qadir et al., 2016). The application of big data analytics assists police to be ready in proper time for any kind of crisis. Thereby, this research formulates the following hypothesis statement:

Hypothesis: 1 "Big data analytics has a significant effect on predictive policing"

2.6.2 The Relationship Between Big Data Analytics and Crisis Management

The association between big data analytics and crisis management has been examined in the past. The outcome of previous studies reveals a significant correlation between these two variables. Hence, to confirm this relationship, this section reviews the empirical evidence to link big data analytics with crisis management. This study has surveyed this relationship in the literature and summarized the findings and conclusions reached by scholars in the past. According to the literature, big data analytics has a direct impact on crisis management in a variety of sectors and industries, and this include organizations worked in the field of law enforcement (Kosciejew, 2020). With the introduction of big analytical tools, vast unstructured text, such as papers, internet blog, social posts and comments, audios in social media, may be simply evaluated for crisis management (Han et al., 2017). According to crisis management theory, big data may guide the course of a possible crisis and has generated opportunities for enhanced control over unexpected events.

Many scholars are working on using big data to read trends and agendas in order to gain insights into big data using various data mining techniques for responding to unknown crises and future events in this regard (Koronis and Ponis, 2018; Park and Alenezi, 2018). There is strong claim that big data techniques may be utilized to handle enormous amounts of crisis-related data in order to provide insight into the rapidly changing situation and help drive an effective catastrophe response (Qadir et al., 2016). Furthermore, each country must establish a public crisis management strategy in order to respond to crises that cause social upheaval. Park's research (2021) demonstrates how a country might use big data analytics to uncover "important social issues" and then construct a subsequent strategy or decision-making system to develop a public communication or new policy in the future.

Furthermore, the effectiveness of big data analytics is critical to ensuring that unexpected situations are deemed destructive and harmful in political, economic, societal, or environmental affairs involving security issues, particularly when they occur suddenly and unexpectedly, with little or no warning. As a result, in a crisis that causes social upheaval, it is critical to develop a crisis management plan quickly (Doka et al., 2017). While Watson et al. (2017) provided findings from a case study of a big data survey, which support prior findings that big data can contribute to crisis response efforts by providing effective information for decision-makers. They concluded that expanded utilization of vast volumes of

datasets, particularly big data analytics, can positively influence crisis preparation steps in the right time and help organizations to respond properly.

In the same vein, Bellomo et al. (2016) opted that leveraging big data to understand crisis management in extreme conditions and security threats is the best choice for crisis response. They further suggested that the presentation of an overview of community dynamics and safety issues demonstrated that the literature in this sector can make useful contributions to crisis management in evacuation circumstances during times of crisis. In the same context, Ma and Zhang (2017) proposed that big data analytics be integrated into the knowledge management process to increase data processing and crisis response capabilities. Their case study demonstrates that the proposed knowledge management method improves situation awareness and decision making while dealing with a social security crisis. While Doka et al. (2017) discovered a strong relationship between big data applications and crisis management, particularly crisis connected with riots in the community. Based on empirical data and previous research findings. This research assumes that big data analytics and crisis management are linked to each other. Based on the preceding explanation, the following hypothesis is elaborated:

Hypothesis: 2 “Big data analytics has a significant effect on crisis management”

2.6.3 The Relationship Between Crisis Management and Predictive Policing

The literature review reveal that crisis management has a significant impact on predictive policing. This claim needs further examination and providing empirical evidence to confirm the connection between crisis management and predictive policing. Researchers in the past have evaluated the link between crisis management with predictive policing. However, this study will attempt to validate this relationship and compare it with the results from other research projects. As mentioned earlier in this chapter, the overall crisis life cycle can be divided and analyzed into three stages namely before, during, and after a crisis (Twigg et al. 2004). Any efforts focused on preventing impending crises will also be part of the first stage in the crisis management. The various different big crisis analytics tasks that can be performed on big crisis data such as (a) various discovery tasks (e.g., clustering outlier detection, or correlation analysis (to detect repeating patterns); and (b) various predictive tasks (e.g., classification, regression, and finally recommendation (whereas some preference is predicted) (Qadir et al., 2016).

Some scholars found that effective, smart and proactive policing is clearly desirable to simply reacting to criminal acts. Although there are many methods and techniques to help police officers respond quickly to crime and conduct accurate investigations, crisis management tools are essential for predictive policing so that to identify where and when a crime is expected to occur, and who is the individual likely to be responsible for committing the crimes (Waller et al., 2013). Despite there are limited studies that examined the direct relationship between crisis management and predictive policing, there lots of debates on these variables which required further investigation to verify the association between them. In the light of the previous claim, and other supporting findings on the relationship between crisis management and predictive policing, the following hypothesis is proposed:

Hypothesis: 3 “Crisis management has a significant effect on predictive policing”

2.6.4 The Mediation Role of Crisis Management

Despite there are few studies that examined the direct relationship between big data analytics and predictive policing, the role of crisis management to mediate this relationship has not been reported in the domain of police there which required further investigation to verify the association between them. Police officers who engage in the law enforcement are constantly looking for efficient crime-reduction methods, either through big data analytics or by the adoption of crisis management tools. Whereas reducing crimes is the ultimate goal of every police so that to decrease social harm, strengthens communities, and so promoting homeland security. The use of big data analytics provides excellent resources for achieving this goal but is it enough to prevent or reduce the effect of crisis. Various studies have previously validated the use of big data analytics in policing, but with the mediation role of crisis management the performance of police will be enhance and can predict not only crimes but also crisis before it happens. Many scholars support the claim that big data analytics is essential for responding to unknown crises and anticipate crimes at the same time (Park and Alenezi, 2018; Gonzalez, 2020; Aruni, 2018).

Aruni (2018) discovered that the use of big data analytics in law enforcement assisted police officers in predicting crimes in a short period of time. Many major police departments in industrialized nations now rely on the algorithms for the predicting crimes. However, the same algorithms could be used in the early stages of crisis management. Mitroff's crisis management model has proposed early stages to anticipate the crisis based on information and reports, which in turn very useful for the mission of policing, while big data is the source for police departments to work in this stage and supporting predictive policing as well. In other words, both crisis management tools and big data analytics are necessary for achieving high level of predictive policing.

Although the algorithms used through big data analytics are typically well-intended for specific purposes, the role of crisis management would enhance the decision-making process for better policing performance (Gonzalez, 2020; Aruni, 2018). As found in the literature, the crisis management theory has not been used to explain how law enforcement agencies deal

with crises through five essential stages (i.e. signal detection; probing and prevention; damage containment; recovery; and learning) and indirectly influence the effect of big data analytics on predictive policing. In other words, to control the consequences of security situation in the country during crises such as pandemic, or political crises, the police need crises management to improve forecasting tools and predict crimes before happening in a large scale violation to the safety of the country (Boeke, 2018). It appears justified to associate the national security system with crisis management as a function of multifaceted national security management the support the anticipation of future crimes and threats on the national security (Bsoul-Kopowska, 2018). It has been demonstrated that it is required for the establishment of an integral sector of national security, as well as strengthening strategic planning, analysis, and crisis management; developing the resilience potential of national security; the adoption of these strategic crisis management by law enforcement agencies will ensure the country's long-term development in the security of the nation (Bondarenko et al., 2021). Hence, the study of the crisis management framework on which big data technology is built is necessary to have a better understanding of how crisis management theory (i.e. Mitroff model) uses big data to avoid the worst impacts of the aforementioned crises (Alexander and Marion, 2020). As a result, this study will investigate the mediation role of crisis management in modeling the relationship between big data analytics and predictive policing. The following hypothesis statement is elaborated to validate this claim.

Hypothesis: 4 “Crisis management mediates the relationship between big data analytics and predictive policing”

3. The Proposed Framework

The proposed framework illustrates how the strength of big data analytics used by the police departments (e.g., large volume of data consisting of numbers) and unstructured (e.g., text data) data which processing such data to produce information and analytics (i.e., big data analytics) could promote predictive policing. In this paper the concepts of big data analytics, predicting policing, crisis management have been introduced, whereas the relationships between them have been identified from the previous studies and reports. A new conceptual framework based on various theories is developed in this study to explain how big data analytics enhance the predictive policing in UAE with the mediation influence of crisis management. Accordingly, this study adopt the Mitroff's five-stages crisis management model (e.g. signal detection; probing and prevention; damage containment; recovery; learning) which will serve as the backdrop for this study to understand how police benefit from crisis management to foster the influence of big data analytics towards predictive policing in UAE The conceptual model of the study, as shown in the Figure 3. below, the constructs of the conceptual framework consists of an independent variable (big data analytics), and a dependent variable (predictive policing), and a mediator variable (crisis management).

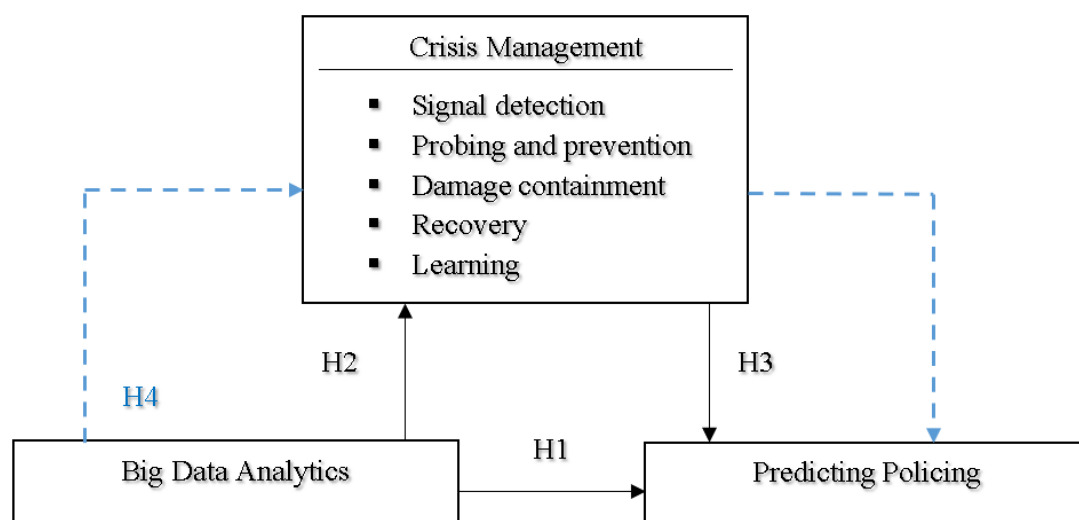


Figure: 3 The conceptual framework of predictive policing

4. Discussion and Conclusion

The purpose of this research was to investigate the effect of big data analytics on predictive policing through crisis management. The literature review in this paper demonstrates the concepts of crisis management and big data analytics, and crises management. The definitions and their measurements have been identified as well. The debate and arguments in this paper is conducted to understand how predictive policing is associated with crisis management and big data analytics, and how police can deal with a large amount of data and information. The discussion also explain the essential policing method used for anticipating crimes, predict criminals, predict perpetrator identities, and predict crime victims. Based on the preceding ideas, this study creates a novel paradigm to investigate the relationship between big data analytics, crisis management, and predictive policing in Dubai. In summary, the police in the industrialized world have embraced predictive policing. While several forms of predictive policing algorithms have been developed, the main goal of these algorithms is to anticipate places of crimes and individuals who are at danger of criminal activity. There is a growing body of knowledge in literature on the issues of predictive policing, with some studies demonstrating a small to large impact on crime reduction.

The discussion and debate in this paper reveal that the majority of scholars appear to agree on the importance of predictive policing discipline to law enforcement in every country. While crisis management and big data analytics linked together directly and indirectly through the influence of crisis management. The application of crises management will help the community in many ways. As one of the key components of a crisis management national plan is the safety and well-being of the citizens. The outcome of this study will help government authorities to achieve the goals behind applying crisis management such as preventing the damage to the market and help organizations in the UAE to survive and sustain reputation, restore stability, return the GDP to its normal rate, keep unemployment to the minimum, and retain the operations of businesses as quickly as possible. In sum, any study that provide empirical evidence on crises management to the public or government agencies will ensure the safety of people and long-term prosperity.

References

- Abdul Samee, M., and Tayyibah, A. (2010). Strategic management in crisis management. Jordan: Dar Jalis Al-Zaman for Publishing and Distribution.
- Agrawal, A., and Choudhary, A. (2016). Perspective: materials informatics and big data: realization of the fourth paradigm of science in materials science. *Appl Mater*, 4(5).
- Alexander, B., and Marion, O. (2020). Data Analytics and Algorithms in Policing in England and Wales: Towards A New Policy Framework. Royal United Services Institute. https://rusieurope.eu/sites/default/files/rusi_pub_165_2020_01_algorithmic_policing_babuta_final_web_copy.pdf.
- Alkathetri, Y., Ameen, A., Isaac, O., Nusari, M., Duraisamy, B. and Khalifa, G. (2019). The Effect of Big Data on the Quality of Decision-Making in Abu Dhabi Government Organizations, https://doi.org/10.1007/978-981-13-9364-8_18.
- AL-Ma'aitah, M. A. (2020). Utilizing of big data and predictive analytics capability in crisis management. *J. Comput. Sci*, 16(3), 295-304.
- Almazrooei, K. K. F. K., bin Othman, M. F., and Siam, M. R. (2021). Influencing of collaboration and communication with community besides interaction of government intervention to improve the police innovative services in Dubai. *International Journal of Entrepreneurship*, 25, 1-13.
- Alosani, M. S., Yusoff, R. Z., Al-Ansi, A. A., and Al-Dhaafri, H. S. (2020). The mediating role of innovation culture on the relationship between Six Sigma and organisational performance in Dubai police force. *International Journal of Lean Six Sigma*.
- Alshamsi, S., Isaac, O. (2019). The effects of intellectual capital on organizational innovation within Abu Dhabi police in UAE. *International Journal on Emerging Technologies*, 10(1), 50-58.
- Amira, A. (2019). Dubai records 99.5% drop in unresolved, disturbing crimes. *Khaleej Times* (Wed 6 Mar 2019). Available on [<https://www.khaleejtimes.com/uae/dubai-records-99-5-drop-in-unresolved-disturbing-crimes>]
- Aruni, Yasmin. (2018). Big Data Analytics in Law Enforcement Case Study: LASER Predictive Policing Program in Los Angeles.
- Bellomo, N., Clarke, D., Gibelli, L., Townsend, P., and Vreugdenhil, B. (2016). Human behaviors in evacuation crowd dynamics: from modelling to big data toward crisis management. *Physics of life reviews*, 18, 1-21.
- Boeke, S. (2018). National cyber crisis management: Different European approaches. *Governance*, 31(3), 449-464.
- Bondarenko, S., Tkach, I., Drobotov, S., Mysyk, A., and Plutytska, K. (2021). National resilience as a determinant of national security of Ukraine. *Journal of Optimization in Industrial Engineering*, 14(1), 111-117.
- Brayne, S. (2017). Big Data Surveillance: The Case of Policing. *American Sociological Review*, 82(5), 977-1008.
- Brian Boudreaux. (2005). Exploring a multi-stage model of crisis management: utilities, hurricanes, and contingency. Master Thesis. University of Florida.
- Bsoul-Kopowska, M. Crisis management in the national security system. in *ICoM 2018 8th International Conference On Management* (p. 116).
- Cao, M., Chychyla, R., and Stewart, T. (2015). Big Data analytics in financial statement audits. *Account Horiz*, 29(2), 423-9.
- Carrie, B. S., and James, S. (2017). Policing, crime and big data, towards a critique of the moral economy of stochastic governance. *Crime Law Soc Change*.
- Chahal, H., Jyoti, J., and Wirtz, J. (2019). Business Analytics: Concepts and Applications. In *Understanding the Role of Business Analytics*; Springer: London, UK, 1-8.
- Chan, J., NSW Law Research Paper No. 20-82, Available at SSRN: <https://ssrn.com/abstract=3488882>
- Coombs, g. Third Edition. Thousand Oaks, CA: Sage.
- De Mauro, A., Greco, M., and Grimaldi, M. A. (2016). Formal definition of Big Data based on its essential features. *Libr Rev.*, 65(3), 122-35.
- Doka, K., Mytilinis, I., Giannakopoulos, I., Konstantinou, I., Tsitsigkos, D., Terrovitis, M., and Koziris, N. (2017). Exploiting social networking and mobile data for crisis detection and management. In *International Conference on Information Systems for Crisis Response and Management in Mediterranean Countries*, Springer, 28-40.
- Ericson, R. V. (2007). Crime in an insecure world. Cambridge: Polity.
- Fajri, C., and Mawadati, S. (2018). Kulon Progo Regency government crisis management. *ASPIKOM Journal*, 3(4), 783.
- Fink, S. (1986). Crisis management: Planning for the inevitable. New York: American Management Association.
- Giest, S. (2017). Big Data for Policymaking: Fad or Fasttrack? *Policy Sciences*, 50(3), 367-382.
- Gonzalez, F., G. (2020). AI and law enforcement: Impact on fundamental rights. *European Parliament Think Tank*, 1-87.

- Gourisha, S., and Abdul, R. (2020). Big Data an Interesting Tool for Policing and Law Enforcement to Ensure the Safety, Health, Possessions of Citizens, and To Prevent Crime and Civil Disorder. *International Journal of Innovative Technology and Exploring Engineering*, 9(11), 225-228.
- Grover, V., Chiang, R. H. L., Liang, T., and Zhang, D. (2018). Creating Strategic Business Value from Big Analytics: A Research Framework. *J. Manag. Inf. Syst.*, 35, 388-423.
- Gstrein, O. J., Anno, B., and Andrej, Z. (2020). Ethical, legal and social challenges of Predictive Policing. *Catolica Law Review*, 3(1), 77-98.
- Günther, W. A., Mehri, M. H. R., Huysman, M., and Feldberg, F. (2017). Debating big data: A literature review on realizing value from big data. *The Journal of Strategic Information Systems*, 26(3), 191-209.
- Hagstrom, M. (2012). High-performance analytics fuels innovation and inclusive growth: use big data, hyperactive connectivity and speed to intelligence to get true value in the digital economy. *J Adv Anal*, 2, 3-4.
- Han, M. M. C., Kim, Y. S., Lee, C. K. (2017). Analysis of news regarding new southeastern airport using text mining techniques. *Smart Media Journal*, 6(1), 48-54.
- Hashem, I. A. T., Yaqoob, I., Anuar, N. B., Mokhtar, S., Gani, A., and Khan, S. U. (2015). The rise of big data on cloud computing: Review and open research issues. *Inf. Syst.*, 47, 98-115.
- Hayes, W. J. (2015). Case studies of predictive analysis applications in law enforcement. PHD Thesis. Naval Postgraduate School: USA.
- Henriques, A. C. V., de Souza Meirelles, F., and da Cunha, M. A. V. C. (2020). Big data analytics: achievements, challenges, and research trends. *Independent Journal of Management and Production*, 11(4), 1201-1222.
- Ho, A. T. K., Roman, Z. J., and Wu, M. Y. (2021). Big Data applications: exploratory data analytics of public safety concerns. In *Research Handbook on E-Government*. Edward Elgar Publishing.
- Hung, T. W., and Yen, C. P. (2021). On the person-based predictive policing of AI. *Ethics and Information Technology*, 23(3), 165-176.
- Ifeyinwa Angela Ajah, and Henry Friday Nweke. (2019). Big Data and Business Analytics: Trends, Platforms, Success Factors and Applications. *Big Data Cogn. Comput*, 3(32), 1-30.
- Ingrams, A. (2019). Public values in the age of big data: A public information perspective. *Policy and Internet*, 11(2), 128-148.
- Jansen, F. (2018). Data Driven Policy in the Context of Europe. Working Paper. Cardiff: Data Justice Lab May, 7.
- Jens, K., and Michael, B. (2021). Smart cities, big data and urban policy: Towards urban analytics for the long run. *Cities*, 109, 102992.
- Junhong, R. A., and Vanhala, G. S. (2010). The crisis management in Chinese and Estonian organizations. *Chinese Management Studies*, 4(1), 18-36.
- Kaffash, S., Nguyen, A. T., and Zhu, J. (2021). Big data algorithms and applications in intelligent transportation system: A review and bibliometric analysis. *International Journal of Production Economics*, 231, 107868.
- Kitchin, R. (2014). Big Data, new epistemologies and paradigm shifts. *Big Data and Society*. <https://doi.org/10.1177/2053951714528481>.
- Koronis, E., and Ponis, S. (2018). Better than before: The resilient organization in crisis mode. *Journal of Business Strategy*, 39(1), 32-42.
- Kosciejew, M. (2020). The coronavirus pandemic, libraries and information: A thematic analysis of initial international responses to COVID-19. In *Global knowledge, memory and communication*.
- Kude, T., Hoehle, H., and Sykes, T. A. (2017). Big data breaches and customer compensation strategies: personality traits and social influence as antecedents of perceived compensation. *Int J Oper Prod Manage*, 37(1), 56-74.
- Lerbinger, O. (1997). The crisis manager: Facing risk and responsibility. Mahwah, NJ: Erlbaum.
- Ma, Y. and Zhang, H. (2017). Enhancing knowledge management and decision-making capability of china's emergency operations center using big data. *Intelligent Automation and Soft Computing*, 1-8.
- MAMPU (2016). Public Sector Big Data Analytics. <http://www.mampu.gov.my/ms/dataraya-sektor-awam-drta>.
- Mayer-Schönberger, V., and Cukier, K. (2013) *Big Data: A Revolution that Will Transform How We Live, Work and Think*, London, UK: John Murray.
- McAfee, A., and Brynjolfsson, E. (2012). Big Data: the management revolution: exploiting vast new flows of information can radically improve your company's performance. But first you'll have to change your decision making culture. *Harvard Bus Rev*, 90, 60-69.
- McFarland, D. A., and McFarland, H. R. (2015). Big Data and the danger of being precisely inaccurate. *Big Data and Society*, 2(2), 1-4. Challenges and analytical methods. *Journal of Business Research*, 70, 263-286.
- Meijer, A., and Wessels, M. (2019). Predictive policing, Review of Benefits and drawbacks. *International Journal of Public Administration*, 42, 1031-39.
- Mikalef, P. (2018). Big data analytics capabilities: a systematic literature review and research agenda. *Inf Syst e-Bus Manage*, 16(3), 547-78.
- Mitroff, I. I. (1994). Crisis management and environmentalism: a natural fit. *California Management Review*, 36(2): 101-113.
- Mohamed, A., Nahafabadi, M. K., Wah, Y. B., Zaman, E. A. K., and Maskat, R. (2019). The state of the art and taxonomy of big data analytics: View from the new big data framework. *Artif. Intell. Rev.*, 1-49.
- Mohebi, A., Aghabozorgi, S., Wah, T. Y., Herawan, T., and Yayapour, R. (2016). Iterative big data clustering algorithms: A review. *Softw. Pract. Exp.*, 46, 107-129.
- Mugari, I., and Emeka E. O. (2021). Predictive Policing and Crime Control in the United States of America and Europe: Trends in a Decade of Research and the Future of Predictive Policing. *Social Sciences*, 10(234).
- Nunavath, V., and Goodwin, M. (2018, December). The role of artificial intelligence in social media big data analytics for disaster management-initial results of a systematic literature review. In *2018 5th International Conference on information and communication technologies for disaster management (ICT-DM)* (pp. 1-4). IEEE.
- Oatley, G. C. (2021). Themes in data mining, big data, and crime analytics. *Wiley Interdisciplinary Reviews: Data Mining and Knowledge Discovery*, e1432.
- OECD (en-Driven Public Sector, OECD Digital Government Studies, OECD
- Park, Y. tional enterprises using a data mining technique. *Journal of Management Information and Decision Sciences*, 21(1), 1-14.
- Perry, W. L., McInnis, B., Price, C. C., Smith, S. C., and Hollywood, J. S. (2013). Predictive policing: the role of crime forecasting in law enforcement operations, Rand Corporation, Santa Monica, CA.
- Qadir, J., Ali, A., and ur Rasool, R. (2016). Crisis analytics: big data-driven crisis response. *Int J Humanitarian Action* 1, 12.
- Qadir, J., Ali, A., and ur Rasool, R. (2016). Crisis analytics: big data-driven crisis response. *Int J Humanitarian Action* 1, 12.
- Qasim, S. rformance: the mediating role of knowledge management
- Ragini, J. e and recovery through sentiment analysis. *International Journal of Information Management*, 42, 13-24.
- Sa'diyah, H. (2013). Crisis management of the Indonesian Islamic University (UII) Yogyakarta in overcoming the UNISI Mapala case. *Journal of Chemical Information and Modeling*, 53(9), 1689-1699.
- Salam, A. (2021). Dubai police use data and surveillance to cut crime in Deira district. Available on [<https://www.thenationalnews.com/uae/2021/09/19/dubai-police-use-data-and-surveillance-to-cut-crime-in-deira-district/>]
- Sandhu, A., and Fussey, P. (2021). The 'uberization of policing'? How police negotiate and operationalize predictive policing technology. *Policing and Society*, 31(1), 66-81.

- SharesPost, Inc. (2017). Company Report Palantir: Redefining Analytics, Augmenting Intelligence, and Unlocking Secrets. Shares Post Research LLC.
- Singh, D., and Reddy, C. K. (2015). A survey of Platforms for Big Data Analytics. *J. Big Data*, 2, 8.
- Smith, R. D. (2005). Strategic planning for public relations. New Jersey: Laurence Erlbaum Associates Publishers.
- Space Imaging Middle East (SIME). (2016). Dubai Police Unveils 'Crime Prediction' Software. Available on [https://www.businesswire.com/news/home/20161221005613/en/Dubai-Police-Unveils-%E2%80%9CCrime-Prediction%E2%80%9D-Software]
- Stubbs, E. (2014). Big data, big innovation: enabling competitive differentiation through business analytics. Hoboken: Wiley.
- Sun, J. (2015). Leverage RAF to find domain experts on research social network services: a big data analytics methodology with MapReduce framework. *Int J Prod. Econ.*, 165, 185–93.
- Tarawneh, M. I. (2011). Crisis management. Amman, Jordan: Dar al-Yarā' for Publishing and Distribution.
- Thirathon, U. (2016). Performance impacts of Big Data analytics. In: PACIS.
- Tsai, C.-W., Lai, C.-F., Chao, H.-C., and Vasilakos, A.V. (2015). Big Data Analytics: A survey. *J. Big Data*, 2, 21.
- Twigg, J. (2004). Disaster Risk Reduction: Mitigation and Preparedness in Development and Emergency Programming. Humanitarian Practice Network, Overseas Development Institute.
- Uthayasankar, S., Muhammad, M. K., Zahir, I., and Vishanth, W. (2017). Critical analysis of Big Data challenges and analytical methods, *Journal of Business Research*, 70(2017), 263-286.
- Waller, M. A., and Fawcett, S. E. (2013). Data science, predictive analytics, and big data: a revolution that will transform supply chain design and management. *Journal of Business Logistics*, 34(2), 77-84.
- Wang, Y., Kung, L., and Byrd, T. A. (2018). Big data analytics: understanding its capabilities and potential benefits for healthcare organizations. *Technol Forecast Soc Chang*, 126, 3–13.
- Watson, H., Finn, R. L., and Wadhwa, K. (2017). Organizational and societal impacts of big data in crisis management. *Journal of Contingencies and Crisis Management*, 25(1), 15-22.
- Wedel, M., and Kannan, P. (2016). Marketing analytics for data-rich environments. *J Mark*, 80(6), 97–121.
- Zwitter, A. (2015). Big data and international relations. *Ethics and International Affairs* 29(2), 377–89.